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C1Po1A-01: Numerical simulation of active magnetic regenerative refrigeration for hydrogen liquefaction

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In the coming hydrogen society, the development of hydrogen infrastructure is an urgent task. Hydrogen infrastructure can be broadly categorized into "production,""transportation and storage,"and "utilization." Among these, it is desirable to use liquid hydrogen for storage and transportation from the viewpoint of energy density. On the other hand, since the liquefaction temperature of hydrogen is 20 K at 1 atm, the production of liquefied hydrogen requires a large amount of energy. To realize a hydrogen society, it is essential to reduce the price of hydrogen, and for this purpose, it is desirable to improve the liquefaction efficiency of hydrogen as much as possible. The liquefaction efficiency of conventionally used so-called gas refrigeration systems, which use compression and expansion of gas, is typically about 25%, and it is difficult to dramatically improve it further.

Magnetic refrigeration is a cooling method that utilizes the magnetocaloric effect of magnetic materials and is known to have a theoretical efficiency of over 50%. Among various magnetic refrigeration methods, the AMR is the most practical because it can operate over a much wider temperature range than ordinary magnetic refrigeration methods. On the other hand, since AMR uses heat exchange gas, the dynamic heat transfer characteristics of the heat fluid as well as the thermophysical properties of the magnetic material are important to understand the characteristics of AMR. Therefore, many parameters exist in AMR, making optimization difficult. In this study, a calculation model of AMR was constructed using ANSYS, and temperature distribution, freezing capacity, etc. were calculated and compared with experiments.

Author: Dr KAMIYA, Koji (National Institute for Materials Science)

Co-authors: Dr UCHIDA, Akira (National Institute for Materials Science); Dr NATSUME, Kyohei (National Institute for Materials Science); Mrs OKIHARA, Saori (National Institute for Materials Science); Dr NUMAZAWA, Takenori (National Institute for Materials Science); Mr SHIRAI, Tsuyoshi (National Institute for Materials Science)

Presenter: Dr KAMIYA, Koji (National Institute for Materials Science)

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